January	16, ...	– 0·10
,,	21, ...	– 0·10
,,	26, ...	+ 0·15
,,	31, ...	+ 0·25
		+ 0·20
February	5, ...	+ 0·15
,,	10, ...	– 0·25
,,	15, ...	+ 0·15
,,	20, ...	+ 0·55
,,	25, ...	– 0·05
		+ 0·55

March	2, ...	+ 0·35
,,	7, ...	+ 0·40
,,	12, ...	+ 0·55
,,	17, ...	+ 0·20
,,	22, ...	+ 0·45
,,	27, ...	– 0·15
		+ 1·80
April	1, ...	+ 0·50
,,	6, ...	– 0·25

Mr. Edward Clibborn read a paper—

On the Partial Combustion of Fluid Iron, described by Mandelslo in 1639; and of Solid Iron, now publicly practised in Dublin by means of a Cold Blast of Common Air.

The first process referred to in the title of this communication is described at p. 160 of the English version of Mandelslo's travels, published in London, in 1669. We there find that "They (*the Japanese*) have, among others, a particular invention for the melting of iron, without the using of fire, casting it into a tun done about on the inside with about half a foot of earth, where they keep it (*melting**) with continual blowing, and take it out by ladles full, to give it what form they please, much better and more artificially than the inhabitants of Liege are able to do." When these remarks were written in 1639, this city produced the best fabrics in iron then manufactured in Europe.

To a cursory reader this extract conveys the notion, that the Japanese, amongst other processes for working the metals, then unknown in Germany, were acquainted with one which enabled them to melt iron without the use of fire in any form. But a judicious person, acquainted with the iron manufacture, will perceive that the words, "*casting it* (the iron) *into a tun*" qualify the previous statement, "*without the using of fire;*" for they imply that the iron, having been previously melted by fire, was afterwards cast, in the liquid state, not into wooden flasks or boxes of various shapes and sizes, containing sand moulds, in which the melted iron would, under ordinary treatment, have been allowed to remain at rest, and cool, and harden into all sorts of shapes, with or without the impact of air, in the Japanese plan, on the contrary, was, "cast" into, or allowed to flow from a melting furnace into an open wooden "tun," or large tub, such as might have been used in a German brew-house about 230 years ago. This tun was lined internally, as he tells us, "with about half a foot of earth," or fire-clay, and not moulding sand. This clay, from its tenacity, was necessary to fit it for the purpose. It was not superficial or common earth, but a sort of fire-lute, not only capable of

* The context shows that this word is understood.

resisting the heat of the molten metal, but of insulating or hindering the progress of the heat towards the staves of the tun, so long as the blowing of the heated iron with cold air was continued.

Our author took it for granted, that his reader was able to fill up and complete his narrative, from his own knowledge of the iron manufacture, as practised in Europe at the time he wrote, and not leave it in its present imperfect state, which, to the ignorant and uninformed reader, appears to be inconsistent with itself, and utterly impracticable.

We are not told how hot the iron was before the blowing process commenced; or how much hotter it might have become under that process; or how long, or how many minutes it was continued; what test the Japanese iron-master adopted to enable him to know when the blowing process was completed, or when he might set the men to work with the ladles to pour the liquid iron into the moulds, or cast it into pigs or bars, or put it through some other process.

Enough is, however, explained to enable us to compare roughly the Japanese process with that proposed in 1856, by Mr. Bessemer, who then astonished many persons, who had hitherto been considered conversant with the management of liquid iron, by bringing forward a plan, as new, for blowing molten iron with atmospheric air, which plan, in all essentials, was so like the Japanese, that we may illustrate or explain the one by the other; and, perhaps, be led to infer that somehow the modern plan of blowing melted iron was really no more than a revival in Europe, in 1856, of the old plan which Mandelslo saw in Japan in 1639.

It is, however, possible, that Mr. Bessemer might have arrived at his process by other means; and this is the more likely, as the other process of blowing heated iron we have hereafter to call attention to, had been previously in use in England. In it we discover the application of the same principle to practice, but in a minor degree, both as to the quantity of iron operated on by the blast of cold air, and also in the inferiority of the temperature which is obtained by the blowing process.

It is very much to be regretted that Mandelslo's account of the Japanese method of blowing melted iron with cold air, and thereby heating it by partially burning it and its alloys, is so very imperfect; but with the aid of Mr. Bessemer's published plans, we can perfectly understand it. Mandelslo clearly gives the Japanese the ownership of the process he notices; and we can hardly think he would have done so, had he seen or heard of it in the East Indies, Tartary, or Persia, or of any similar process.

He, however, takes no notice of the comparative scarceness of iron in Japan, remarked by all modern visitors to that country, and of the extreme abundance of iron, and the great craft of smiths of all kinds in China, facts which our traveller was ignorant of, or leaves us to gather from other witnesses. He, however, tells us that the Japanese claim to have had from the earliest times a great intercourse with China. It hence follows that they might have obtained from China this curious process of blowing hot iron with cold air, and partially burning it and its alloys, and thereby improving its quality for general or special purposes;

though no traveller, that I know of, to China, or any other part of Asia, has distinctly noticed the process used in Japan, or any other like it, as involving the chemical principles which give it peculiarity and excellence.

I believe there is nothing recorded by any old or modern traveller to Japan, which will justify us in considering the Japanese, any more than the Chinese, the Hindoos, or other Asiatics, an inventive people. Latterly the Japanese have exhibited wonderful tact in picking up information in the arts and manufactures from the Europeans they have come in contact with; so it is quite within the limits of probability, that they got their "particular invention," as our traveller calls it, from the Chinese, or the parties they got their iron from originally, as very little is said to be found native in Japan.

If our argument be correct, the process may not be Japanese, but Chinese; and they may still use it in those districts where they reduce the iron from the ore, or purify it for ulterior operations. Their very tough iron clamps and wire may be made of blown iron. That the Chinese possess many metallurgic processes altogether unknown in Europe is beyond a doubt; and this one of blowing hot iron, and making it hotter with a cold blast of common air, may be one of them. But then it is not likely that the Chinese themselves invented the process, which appears to point to a method for reducing iron on a very small scale from the ore in an earthen crucible; which, we can imagine, was removed from the fire, and its contents, less the molten button at the bottom of it, blown aside or away, by the agency of a powerful circular bellows, used previously for urging the fire in which the earthen crucible was heated, and the iron reduced or melted.

Now this process, on a small scale, might lead at once to the blowing of hot iron on a large one, if it were found that the quality of the iron was much improved by it; or that the contents of one crucible might be kept hot, or made hotter by it, while the iron contents of other crucibles might be emptied into it, and all thoroughly blended into one mass, without the aid of another fire, or the labour and danger of lifting a full or heavy crucible from one place to another.

In practice the lining of the wooden tun with six inches of earth was like a great modern pot of clay, used for melting black bottle-glass, being neither more nor less than a gigantic crucible,* so constructed and dried that it would bear the heat without cracking, and for a sufficient time† confine it, till the blowing process was completed.

* Though Mandelslo states nothing of the means adopted for preparing the earthen lining of the "tun," it is probable that it was not only air-dried, but that fire was used to dry it, and possibly to heat it, before the iron was cast into it.

† As we are not informed how the blast of cold air was applied, we cannot form a comparison of Mr. Bessemer's process, or give a reasonable guess as to the time the liquid iron was operated on. It seems as if the blast in the Japanese process was directed strongly downwards, and slightly divergent from the centre, so as to produce motion in the mass, and blow the scales or scoriæ produced to the side of the vessel.

As Mandelslo tells us nothing about the use of steam, or any contrivance for heating the air used in the blowing, the Japanese process may be considered as having been a simple exaggeration of the process we have ventured to indicate, as having been used by a central Asiatic people who, at a very early period, reduced iron in crucibles—a plan which is still used by those who in central Asia produce that kind of iron which is so much prized in Damascus for gun-barrels, and other purposes in which great toughness is desirable, and which iron is found almost always mixed more or less with striæ of steel.

If it were found that the quality of this iron, and that produced by the Japanese process described by Mandelslo, were the same, and that the central Asiatics at present blow the iron in the crucibles after it is reduced from the ore, our supposition as to the origin of the curious process described by Mandelslo might be considered established.

Though found in use in Japan on the large scale, in 1639 (possibly by Chinese traders or their agents there), it is extremely probable that it is very much older in other parts of Asia; and on the small scale, as above suggested, perhaps it is as old as any other metallurgic process now in use in Asia; for iron tools and weapons have been found in the very lowest strata of those numerous courses of clay, brickwork, and pottery, which have been cut through in all the recent explorations in the old sites of the cities, fortifications, temples, and palaces near the Tigris and Euphrates. In every instance, as in the excavations made by Captain Taylor,* iron things are at the bottom,—indicating in these regions, not a later but an earlier age, in certain parts of Asia, for iron than for copper, silver, gold, and tin, and their compounds; all of which appear to have been later productions, and originally derived by means of trade or war with other countries, where these metals were themselves native.

I have now to call attention to the second process noticed in the title to this paper. It is publicly practised in Dublin, by Mr. Buckley, in James's-street, who claims to be manufacturer of the best horse-shoe nails to Her Majesty. He informs me that he learned it from a man of the name of Inman, who belonged to the York Militia, and who left that regiment in Dublin above forty years ago,† when he secretly introduced this method for making horse-shoe nails into this city. In principle

* See his paper on Cromlechs found in the Deccan, read to the Academy, on the 12th of May, 1862.

† Before this time horse-shoe nails were made of the best Swedish iron generally; but whether the nailers blew them with the common bellows before, or annealed them after fabrication, to soften them, I am not able to say. There were secrets known to certain blacksmiths who made these nails; but whether the cold blast was used in Ireland before Inman introduced it, I have not learned. A method for making horse-shoe nails, very barbarous, as it is exactly the same with the Caffre method of forging iron weapons, had been, before Inman's time, introduced into the county of Clare, from the county of Cork, by a person of the name of John Hoare, as has been explained to me by Mr. E. Curry, who describes Mr. Hoare to have been a great scholar and original genius. This process consisted in using two stones, instead of the steel-faced hammer and anvil, for making horse-shoe nails, it having been found that the stones abstracted less heat from the nail-rod

his process is exactly the same as the Japanese; but it is necessarily practised on a very small scale, the amount of iron operated on by the blowing process, at any time, being limited to so much as will form the point and shank of a horse-shoe nail.

My inquiries have failed to trace the history of this process or its antiquity in England; but I find it is now practised extensively at Wolverhampton, and in some other places; and I would be disposed to conclude that it had been very generally practised in England, probably by the gipsies,* long before Inman introduced it into Dublin, on account of the old belief or impression, which is certainly older than fifty years, that the barrels made for fowling-pieces and pistols from old horse-shoe nail iron were less likely to burst than those made out of any other denomination of European iron, and were as safe as the best barrels made of Damascus iron, or its Spanish imitations. Thus comparing or placing the horse-shoe nail iron on a par with the Damascus, which, in the East, where great attention was given to fire-arms, was considered the best. The real or supposed similitude in the quality of the best European and Asiatic irons, used for gun-barrels, would lead one to suspect that the irons they are made of had somehow gone through the same or an analogous process of being blown with cold air when hot, and been partially burned; and that this operation had given to all of them their peculiar toughness, due to a striated or filamentous structure, which obliterated the original crystalline arrangement of their particles, a change in the quality of the iron which is said to be effected by the Bessemer process of blowing the liquid metal with cold air.

It is this similitude in the organic structure of the iron of the barrels of guns made of horse-shoe nail iron, and of Damascus twisted iron, that leads me to infer that the Asiatic iron there used, though not procured in Japan, must have been cold blown, and partially burned when hot, like that tough iron we obtain from the welding together of bundles of horse-shoe nails made of cold-blown nail-rod iron.

In reducing the iron used in Damascus, the button found in the bottom of the crucible is said to be hammered into a small bar, which bar we may consider equivalent to a horse-shoe nail; but whether it is also blown in the process of hammering it out, or not, I am not able to say, though I would suspect it was, because the blowing would enable

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than the iron or steel tools, within the time necessary to fashion the nail. This process with the stones points to Africa for its origin; but the several processes of burning a portion of the iron we have to consider in this paper all point to central Asia, noticed by the prophet Jeremiah for the peculiarity or superiority of its northern iron or steel.

* If the process of blowing the heated nail-rod be Asiatic, its introduction into England may be due to the gipsies, who are iron-smiths by profession, and possibly, as their language indicates, from northern Asia, and probably inheritors of many secrets of the iron craft, and this one amongst others. It looks also as if the secret of the polarity of magnetic iron ore, or the loadstone and magnet, had been known also to the gipsies before its adoption for scientific purposes,—as some navigators objected to its use at all, on the score that it had been previously used by fortune-tellers and cheats for purposes of deception; and, as the gipsies led the way in this delusion, they may be the parties alluded to.

the operator to make it hold the heat for some time after it was removed from the crucible. In this case the continued blowing with the cold air would save the use of a forge fire, and a second heating of the scraps of iron, and thus economise trouble and expense in their manipulation.

I may now describe the process for burning iron partially, used by the makers of horse-shoe nails in Dublin and elsewhere. The nail-rod is heated in the common forge fire, like any other nail-rod iron; but, instead of being at once submitted to the action of the hammer, it is placed on the anvil so that the heated part of the iron rod overhangs its face on one side. In this position it is exposed for some seconds to a powerful and steady blast of cold air, obtained from a circular bellows, very Asiatic in its character and form. This bellows gives a much greater blast than that used for blowing the fire, due to the greater load placed upon it, which gives a pressure, at the least, of twenty-five pounds to the superficial foot. This may be increased by pressure from the hand of the nailer, who watches the burning of the iron till he thinks it has gone far enough, and then he places the burning iron on the face of the anvil, keeping it more or less in the blast while he hammers it hot. Thus it appears that the usual aphorisms, which apply to the making of nails in a hurry, do not refer to this process at all.

The heated nail-rod, instead of getting cold by the action of the blast, gets hotter and hotter, and burns partially, throwing off innumerable small sparks, which pass off in all directions, their courses not being influenced by the direction of the blast. Scales or small slags form on the hot iron, which are believed to consist chiefly of impurities in the nail-rod. At last the iron begins to melt, and would drop down like melted sealing-wax, if not removed from the direct influence of the blast, as described. By moving the iron more or less into the blast, the nailer is able to moderate and regulate the heat of the portion he is operating on; and this enables him to complete the point and shank of the horse-shoe nail hot, and before any crystallization of the iron begins or is completed, which it is by the hammering and hardening of the common nail when nearly cold. In theory, the nailer's process of blowing the iron of a horse-shoe nail is perfect, for it enables him to make the point and shank of the nail as soft and tough as he likes, while it allows him to make the head of it very hard, and thus withstand the friction to which it is exposed by its contact with the road.

The operation of making a horse-shoe nail by the cold blast process, beyond a doubt, gives the iron it is composed of some characters, both chemical and organic, very different to those possessed by the nail-rod previously. It clearly brings horse-shoe nail iron up to the Damascus standard, in many respects, and may place it above both the Japanese and Bessemer iron, prepared by the cold blast, as it is manipulated on a much smaller scale, and consequently is more completely exposed to the purifying action of the blast.

In the arts many applications of the nailer's cold blast process might be found, in cases where it would be expedient to keep iron hot without the immediate application of fuel. In rivet work it might be found most

valuable; and, with some contrivance for heating the blast, its uses may possibly be greatly extended in the manufacture of things made of iron, or of things made of other metals in contact with iron.

But these industrial considerations are out of place here, my object being to deduce scientific considerations from material facts, connected with mechanical art, which I have ventured to speculate on, with the view, if possible, of tracing the original development of a scientific principle, which, though hitherto applied in the arts only, may possibly be turned to account as a means by which we may obtain any amount of iron light, or light produced by the combustion of iron, *per se,* that we may want for scientific purposes.

Iron burned by the horse-shoe nail-maker's process, carried one step further, may be considered to be an aërolith at rest,—the air from the cylindrical bellows moving past it with the same velocity with which an aërolith in motion would, under ordinary circumstances, travel through the lower region of the atmosphere, and there, by friction, first become hot, and next, by impact with oxygen,* begin to burn its iron and nickel, like the heated nail-rod when exposed to the cold blast.

The partial combustion of the iron in the nailer's process, though it in theory, in some respects, resembles that produced by the burning of iron in oxygen gas, differs from it materially, and also from Bessemer's process, in the production of no large explosive sparks, which divert our attention from the iron actually burning. In our process the sparks are very minute, and the burning iron gives a very strong light, its intensity appearing to depend on the violence of the blast. We are thus supplied with a means of producing a large quantity of steady light by the combustion of iron for optical experiments. And as iron-wire may be mixed with other wire, and simple or compound wicks produced, made out of twisted hanks of wire of one or more kinds of metal, we have at our command a ready method for producing lights, which may be compared with light produced by the sun or meteoric bodies, in which there is reason to suspect the combustion of iron and other metallic substances.

So far as the material facts noticed in this paper are concerned, there is nothing actually new in it; yet I cannot find that any one has drawn the attention of opticians and physicists to the nailer's process of partially burning iron, or its analogies with the other processes noticed, and the means it puts at our command of burning iron by itself as a source of light.

Not having tried any experiments on the light produced by the nailer's process of burning iron, I am not prepared to say whether it offers any promise to the photographer; but, as highly heated iron is

* The spark produced by a flint and steel is an example of the combustion of iron, first heated by pressure, and afterwards burnt by motion through the air. Its colour is different to that of iron burnt by the nailer's process, though the colour of that may change with the increase of the blast, and the proportional intensity of the light.

found to have great power in the development of marking ink, it is possible that it may possess for him some advantages over most other kinds of natural and artificial light.

As the progress of machinery is rapidly putting an end to the manufacture of hand-made nails, it is likely that horse-shoe nails will ere long be produced by other methods, and the two plans for making them here noticed be forgotten in the arts, and no memorial of them left beyond this passing scientific notice, should it find a place in the Proceedings of the Academy.

The Rev. S. Haughton, F. T. C. D., read the following paper, by Dr. Fleetwood Churchill, L. K. Q. C. P. I. and L. R. C. S. I., late Assistant Surgeon in her Majesty's Navy :—

On the Rain-Fall and Wind at Simon's Bay, Cape of Good Hope.

The following observations on the rain-fall and wind are offered as a contribution to our knowledge of the climate of the neighbourhood of the Cape of Good Hope. I have not given with them the observations I made on the barometer, and wet and dry bulb thermometers, as I believe that observations made with these instruments have already attracted the notice of meteorologists interested in the climate of the Cape.

My rain-gauge at Simon's-town is *twenty-one* feet from the ground. I was obliged to put it on the roof of my house, to get it clear of the bushes in the garden. The ground the house stands on is, at the outside, *fifty* feet above the sea.

The following Table gives the rain-fall in each month from June, 1859.

Table I.—*Rain-fall at Simon's Bay.*

	1859.	1860.	1861.	1862.
	inches.	inches.	inches.	inches.
January,	. .	0·62	0·59	0·53
February.	. .	1·58	0·10	
March,	. .	1·06	0·49	
April,	. .	1·23	1·82	
May,	. .	4·16	4·01	
June,	5·19	4·65	4·81	
July,	3·22	5·06	3·58	
August,	4·98	1·06	2·46	
September,	2·19	5·61	2·89	
October,	2·85	1·12	0·22	
November,	2·63	1·00	1·27	
December,	0·72	0·50	0·05	
Totals,		27·65	22·29	